PORT ALICE GEODUCK CLAM STOCK

ASSESSMENT SURVEY

FOR THE 1998/1999 SEASON

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Under a cooperative agreement between the Alaska Department of Fish and Game (ADF&G) and the Southeast Alaska Regional Dive Fisheries Association (SARDFA), the Port Alice area, located at Heceta Island in Subdistrict 103-90, was surveyed to estimate geoduck clam biomass. A dive survey was conducted by ADF&G in September 1998 using funds provided by SARDFA. Total geoduck clam biomass was estimated at 266,840 kgs (588,281 lbs). A fishery was scheduled to open in November 1998 with a Guideline Harvest Level of 10,678 kg (23,500 lb) of geoduck clams, but was delayed pending Alaska Department of Environmental Conservation water quality testing.

INTRODUCTION

Geoduck clam assessment surveys have been of limited scope in Southeast Alaska. Stock assessment surveys were first attempted in Southeast Alaska in 1982 at Noyes Island and in 1988 and 1989 at Biorka Island, Kah Shakes, and Gravina Island. Although commercial fisheries have been ongoing since 1985 no additional surveys had been conducted until 1997.

In 1998, a cooperative agreement was entered into between the Alaska Department of Fish and Game (ADF&G) and the Southeast Alaska Regional Dive Fisheries Association (SARDFA). Under the terms of this agreement, SARDFA provided funding to ADF&G to survey geoduck clam populations in the Port Alice area of Subdistrict 103-90 (Figures 1 and 2). The principal goals of this survey were to 1) estimate the density and biomass of geoduck clams in the area, and 2) estimate a potential quota for a commercial geoduck clam fishery.

METHODS

During the spring and summer of 1998, geoduck industry divers performed reconnaissance surveys within the Port Alice area, identifying the most likely sites capable of supporting a commercial geoduck fishery. ArcView® GIS electronic charting software was used to plot reconnaissance transect coordinates and measure shoreline with geoduck habitat. Total estimated shoreline was 4,955 meters and 18 transects were plotted (i.e. one transect every 275 meters of shoreline). Transects were plotted in a general south-to-north, east-to-west direction. A random number (65) was generated between 0 and 275 and represented the location of the first transect (i.e. the first transect was located 65 meters from the zero mark of measured shoreline). Thereafter, each transect was systematically located every 275 meters along the shoreline as defined above. For reference while locating transects in the field, transect coordinates and copies of standard NOAA charts with marked transects were laminated and available aboard each dive skiff and the support vessel.

Geoduck counts were made via scuba along 2-meter-wide strip transects oriented perpendicular to the shore, resulting in an estimate of clams per linear meter of shoreline. Transects extended to a target depth of 17 meters (55 fsw) mean lower low water (MLLW), and did not exceed 21 m (70 fsw) actual depth. Dives were limited to a maximum depth of 21 m (70 fsw) because deeper dives severely limit total bottom time for scuba divers and pose safety risks when conducted repetitively over several days. Though counts were made to the target depth, on many transects counts were also made between the target depth and 21 m (70 fsw). Dives to the target depth include the majority of habitat in which commercial divers normally operate. Diving beyond the target depth to a maximum of 21 m (70 fsw) provides some measure of geoduck density at deeper depths. Transect length varied depending on the slope of the bottom.

Two divers swim as a team along each transect, with one diver holding a 2-meter-rod (a 2.1 cm diameter white PVC tube) in a horizontal position, perpendicular to the census path. Transect direction was maintained by reference to a compass mounted on the rod. The diver carrying the rod counts the number of geoduck clams passing under one side of the rod (usually the left) while the buddy counts geoducks on the other side (usually the right). When geoducks were encountered the divers deployed a tape measure

with a weight on the free end to measure the distance covered while counting clams and provided a rough density estimate of clam beds. Once the tape was deployed, distance was measured to the target depth or until unsuitable clam habitat was encountered (e.g. bedrock).

In addition to recording the geoduck count for each transect, divers also recorded data for start and stop depths, substrate type, percent vegetative cover, vegetative type, and the presence of other species of interest including sea urchins, sea cucumbers, and abalone. Vegetative type was recorded for the two most common types on each transect, with the most prevalent type listed first. Substrates were coded using a key that groups various algae and marine and intertidal plant species into categories according to Appendix A. Similarly, substrate type was recorded as "percent cover" for up to two types, and was coded according to Appendix B.

The beginning and ending time for each transect was recorded to allow for standardization to the mean lower low water (MLLW) tide stage. When the transect length was relatively short (e.g. less than one-half of one full scuba tank was needed to complete the transect), shoreline transects were paired (sides A and B) so that a dive team would censuses one strip while descending, and then a second strip when returning to shore. The second transect in each pair was approximately 15-20 meters to the left (when facing shore) of the first transect.

The density estimate was calculated as the average number of geoducks per meter of shoreline length:

$$D_s = \sum_{i=1}^{n} \frac{c_i}{P} \left(\frac{L_i}{L_T} \right), \qquad (1)$$

where:

D_s = estimated number of geoducks per meter of shoreline,
c_i = count of geoduck clams on each transect i from 1 to n,
L_i = shoreline segment length associated with each transect i,
L_T = total shoreline length,
n = number of transects,
P = either 2 in the denominator and corrects for the 2-meter width, or P = 4 and corrects for each of two transect sides.

Uncertainty in the density estimate is expressed as the percent precision (Table 1). The index is equal to the lower bound of the one-sided 90% confidence interval expressed as a percent of the average density and calculated as:

$$P_D = 100 \left(1 - t_\alpha \frac{s}{D_s \sqrt{n}} \right) \qquad (2)$$

where:

P_D = percent precision of the density estimate,
t_α = t-value from Student's distribution for a one-sided interval with significance level α = 10%,
s = standard deviation of the mean,
D_s = estimated number of geoducks per meter of shoreline,
n = number of transects.

Geoduck Weight Estimates

Following transect surveys, geoducks were collected using commercial water jet harvest gear at suitable transect locations. Because of considerable set-up time, multiple samples from a few transects are more cost effective than sampling individual geoducks from a large number of systematically or randomly-chosen transects. In Port Alice, a total of 32 weight samples were collected from three locations. Appendix E lists the number of samples of geoducks obtained and an estimation of mean weight per geoduck per sampling site.

To collect geoduck samples, a skiff was anchored near a previously surveyed transect, located using Differential Global Positioning System (DGPS), at which point divers descended and randomly sampled the geoducks. Geoducks taken at each transect were kept separate and labeled with the transect number. The date, district, and subdistrict were recorded as well as the transect number, DGPS latitude and longitude to the nearest thousandth of a minute, and number and condition (e.g. broken shells) of sampled geoducks . Samples were processed the same day as they were harvested. After draining, the geoduck shells were wiped dry, numbered sequentially, and whole wet weight (in grams) was measured. The greatest anterior-posterior length of the right valve was measured with calipers (in mm). The right valve is the valve on the measurer's right side when the clam is held with the siphon down and the umbo facing the measurer (see Harbo 1997). Weight, length, shell identification number, date collected, area, and transect number were recorded. The geoducks were then processed and the shells saved for aging.

Mean weight per geoduck within a given area is estimated as:

$$W = \frac{\sum w_i}{n_w} , \qquad (3)$$

where:

W = estimated mean weight per geoduck,
w_i = weight of the *i*th geoduck from the dug samples,
n_w = sample n for weight.

Geoduck Biomass Estimates

The estimate of total geoduck biomass in an area is calculated as:

For linear shoreline estimates,

$$B_{bed} = (D)(W)(L_T) , \qquad (4)$$

where:

B_{bed} = total geoduck biomass per defined area,
D = estimated number of geoducks per meter of shoreline,
W = estimated mean weight per geoduck (in pounds),
L_T = total shoreline length.

Confidence limits for the biomass estimates are based on an estimate of the variance of the biomass (B_{bed}). A variance-of-products formula (Goodman 1960) was used to calculate an estimate of the product of mean density and mean weight per geoduck. If geoduck density and weight per geoduck are independently subject to sampling error (i.e. there is no correlation between density and weight), then the variance of the biomass is:

$$\delta_B^2 = D^2 \frac{\delta_w^2}{n_w} + W^2 \frac{\delta_D^2}{n_D} - \frac{\delta_D^2 \delta_W^2}{n_D n_w}, \qquad (5)$$

where:

δ^2_B = variance of biomass, B,
D = mean density of geoducks,
W = mean weight (pounds per geoduck),
δ^2_D = variance of densities,
δ^2_W = variance of weights,
n_D = number of transects,
n_W = number of geoducks weighed.

Uncertainty in the biomass estimate is expressed as the percent of precision. The index is equal to the lower bound of the one-side 90% confidence interval expressed as a percent of the biomass and calculated as:

$$P_B = 100\left(1 - t_\alpha \frac{s}{D}\right), \qquad (6)$$

where:

P_B = percent precision of the biomass estimate,
t_α = t-value from Student's distribution for a one-sided interval with significance level α = 10%,
s = standard deviation and n-1 degrees of freedom of the mean biomass estimate ($\sqrt{\delta^2_B}$, from equation 5),
D = mean density of geoducks.

The statistical objective for the biomass estimate was for a precision level of 66.7% of the estimated biomass[2]. Biomass estimates not achieving the precision objective are adjusted by the actual precision obtained.

$$B_{adj} = \frac{P_B}{0.667} * B_{bed}, \qquad (7)$$

[2] The statistical objective is that we are at least 90% certain that the harvest rate does not exceed the target harvest rate by more than 50%. This means that a 2% harvest rate could be a maximum of 3% due to uncertainty in counts and weights. A 90% level of certainty is consistent with other dive fisheries (e.g. sea cucumber and sea urchin). The 3% maximum harvest rate translates into a precision level of 66.7%.

where:

B_{adj} = precision adjusted biomass estimate,
P_B = from equation 6, above,
B_{bed} = from equation 4, above.

SURVEY RESULTS AND DISCUSSION

A total of 18 transects with an average overall density of 65.4 clams per meter of shoreline were completed in 1998 to survey geoduck clams in the Port Alice area (Table 1; Figure 2). This represents approximately 324,002 geoducks clams.

A total sample of 32 geoducks were collected to obtain estimates of weight, length, and age. Average weight among the three sites ranged from 572 grams (1.2 lb) at Transect #10 to 1,634 grams (3.6 lbs.) at Transect #4, with an overall weighted average of 941 grams (2.1 lb). Appendix E summarizes the weights collected.

The estimated, non precision adjusted, geoduck biomass in the Port Alice area is 304,764 kg (671,889 lb, Table 1). This biomass estimate has a precision of 58.4% which is less than our target of 66.7%. The 90% of being within 66.7% adjustment for Port Alice is 87.6%. The precision adjusted biomass for the Port Alice area is 266,840 kg (588,538 lb) of geoduck clams.

FISHERY MANAGEMENT

Geoduck clams are long-lived with low and sporadic recruitment, therefore, the objective of geoduck fishery management is to allow low exploitation rates on beds open to commercial harvest. Commercial harvest is restricted to beds for which biomass estimates are available. The guideline harvest level (GHL) for each area is calculated as 2% of the estimated biomass per year (Larson and Minicucci 1997). The biomass estimate contains a precision adjustment where statistical objectives have not been achieved. Harvests are by permit only and historically have been allowed from October 1 through May 31 to avoid the summer spawning and recovery period and to minimize PSP toxin levels.

All miscellaneous shellfish dive fisheries in Southeast Alaska are under a limited entry moratorium (from July 1, 1996 through June 30, 2000), with 169 divers eligible to participate. Each diver is required to have a current Interim Use Permit and a Miscellaneous Shellfish Species Registration/Permit Form during fishing operations. The ADF&G Ketchikan area office has responsibility for management of the Port Alice area.

Geoducks may be sold either fresh or frozen only after satisfactory testing for Paralytic Shellfish Poisoning (PSP) by the Alaska Department of Environmental Conservation (ADEC) prior to sale and

distribution. A certificate and permit from ADEC is required to possess, harvest, process, and distribute geoduck clams for sale for human consumption or bait.

The Port Alice area was initially scheduled to open November 15, 1998 with a GHL of 10,678 kg (23,500 lb) of whole geoduck clams. This represents approximately 4% of the estimated, precision adjusted, harvestable biomass. As of November 1998 ADEC water quality sampling for Port Alice was not available and this area was not opened to commercial harvest. It is expected that this area will open during the following season.

The Port Alice commercial fishing area is in Subdistrict 103-90 in those waters along the northern shoreline of Heceta Island from Surf Point, located at 55°49'58" N. latitude, 133°37'45" W. longitude, then southeast to 55°49'16" N. latitude, 133°30'47" W. longitude.

LITERATURE CITED

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Harbo, Rick M., 1997. Shells and shellfish of the Pacific Northwest. Harbour Publishing, Canada.

Larson, R. and T. Minicucci. 1997. Miscellaneous dive fisheries, 1995/96. In: Shellfish fisheries, Southeast Alaska-Yakutat region 1995/96, report to the Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report No. 1J96-31, Juneau.

Table 1. Biomass estimate and guideline harvest level for geoduck clams for the 1998 Port Alice survey area in Southeast Alaska.

Number of Transects	18
Mean Number of Geoducks per Linear Meter	65.4
Number of Shoreline Meters	4,955
Estimated Number of Geoducks	324,002
Precision of Estimate	59.0%
Number of Geoducks Weighted	32
Estimated Average Weight (lb)	2.07
Estimated Average Weight (g)	939
Estimated Biomass (lb)	671,889
Estimated Biomass (kg)	304,764
Precision of Biomass Estimate	58.4%
Precision Adjustment	87.6%
Precision Adjusted Biomass (lb)	588,538
Precision Adjusted Biomass (kg)	266,840
Target Harvest Rate	0.04
Quota (lb)	23,542
Quota (kg)	10,678
Announced GHL (rounded to nearest hundred lb)	23,500

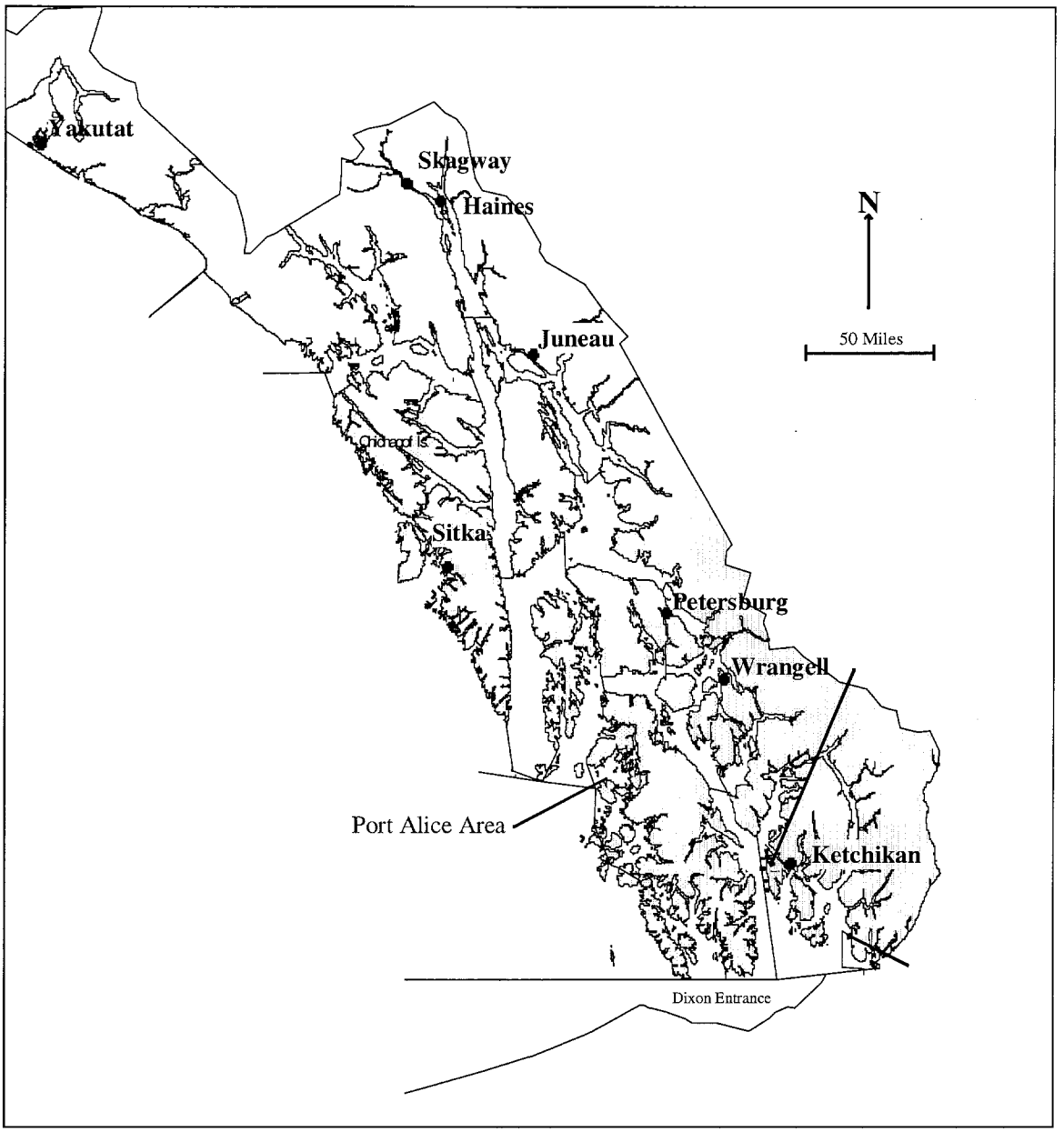

Figure 1. Port Alice geoduck clam survey and commercial harvest area.

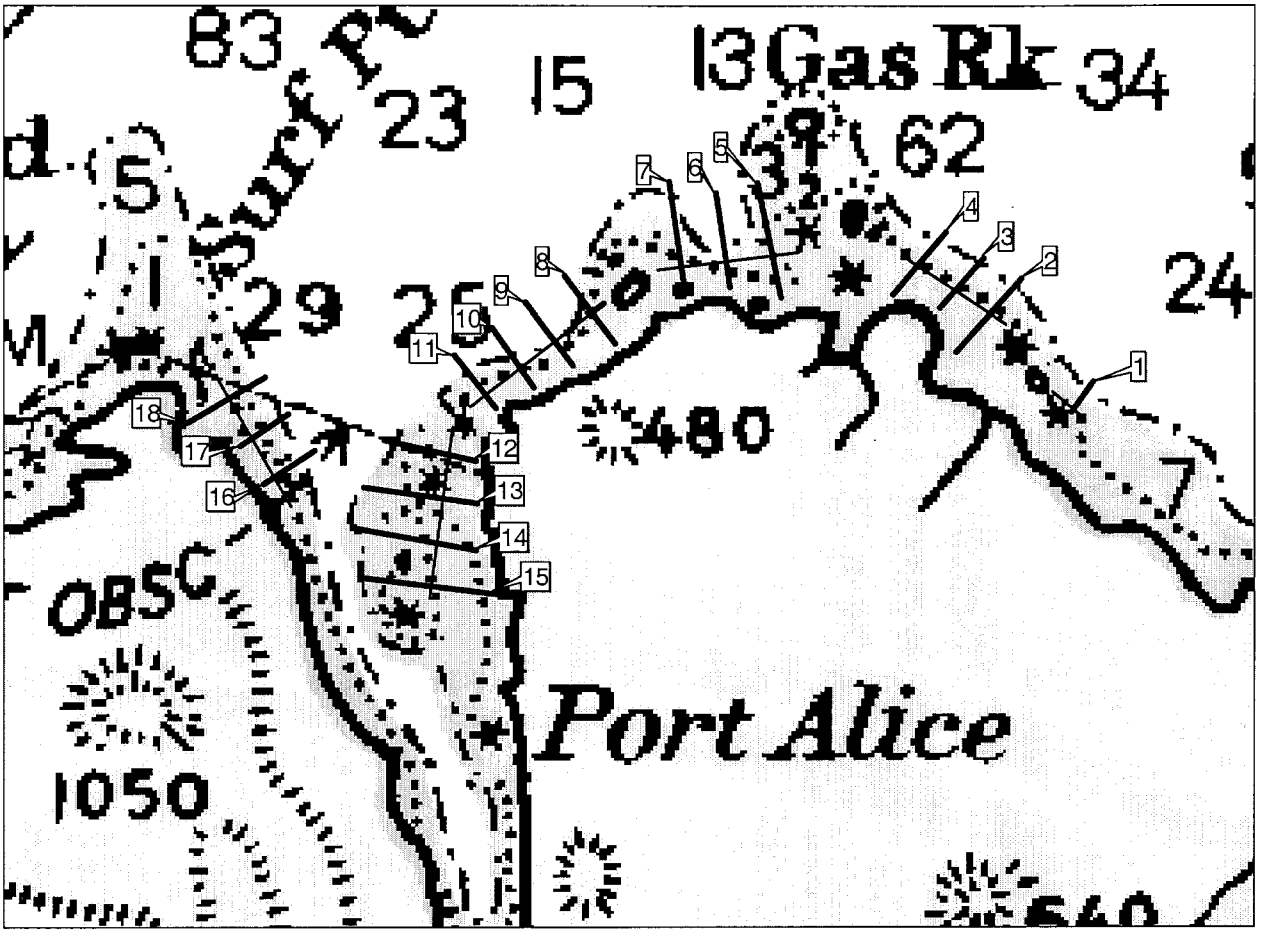

Figure 2. Port Alice 1998 geoduck survey transect locations.

APPENDICES

Appendix A. Key to vegetative substrate types used for the Port Alice geoduck survey.

Code	Expanded code	Species included	Latin names
AGM	Agarum	Sieve kelp	Agarum clathratum
ALA	Alaria	Ribbon kelps	Alaria marginata, A. nana, A. fistulosa
ELG	Eel grass	Eel grass, surfgrasses	Zostera marina, Phyllospadix serrulatus, P. scouleri
FIL	Filamentous red algae	Sea brush, poly, black tassel	Polysiphonia pacifica, P. hendryi, Pterosiphonia bipinnata
FIR	Fir kelp	Black pine, Oregon pine (red algae)	Neorhodomela larix, N.oregona
FUC	Fucus	Rockweed or popweed	Fucus gardneri
HIR	Hair kelp	Witch's hair, stringy acid kelp	Desmarestia aculeata, D. viridis
LAM	Laminaria	split kelp, sugar kelp, suction-cup kelp	Laminaria bongardiana, L. saccharina, L. yezoensis (when isolated and identifiable)
LBK	Large Brown Kelps	Five-ribbed kelp, three-ribbed kelp, split kelp, sugar kelp, sea spatula, sieve kelp, ribbon kelp	Costaria costata, Cymathere triplicata, Laminaria spp., Pleurophycus gardneri, Agarum, Alaria spp.
MAC	Macrocystis	macrocystis	Macrocystis integrifolia
NER	Nereocystis	Bull kelp	Nereocystis leutkeana
RED	Red algae	All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth)	Palmaria mollis, P. hecatensis, P. callophylloides, Dilsea californica, Neodilsea borealis, Mastocarpus papillatus, Turnerella mertensiana
ULV	Ulva	Sea lettuce	Ulva fenestrata, Ulvaria obscura
COR	Coralline algae	Coral seaweeds (red algae)	Bossiella, Corallina, Serraticardia

Appendix B. Key to bottom types used for the Port Alice geoduck survey.

Code	Expanded code	Definition
RCK	Bedrock	Various rocky substrates > 1 meter in diameter
BLD	Boulder	Substrate between 25 cm and 1 meter
CBL	Cobble	Substrate between 6 cm and 25 cm
GVL	Gravel	Substrate between 0.4 cm and 6 cm
SND	Sand	Clearly separate grains of < 0.4 cm
MUD	Mud	Soft, paste-like material
SIL	Silt	Fine organic dusting (very rarely used)
BAR	Barnacle	Area primarily covered with barnacles
SHL	Shell	Area primarily covered with whole or crushed shells
MUS	Mussels	Area primarily covered with mussels
WDY	Woody debris	Any submerged bark, logs, branches or root systems

Appendix C. Port Alice Area (in Subdistrict 103-90) geoduck clam assessment survey, 1998.

GEOUDCK ASSESSMENT TRANSECT DETAILS:

Survey area: Port Alice

Cruise Dates: September 16 - 17, 1998.

Divers: Walker, S. (SW), Doherty, P. (PD), Pritchett, M. (MP), Hebert, K. (KH), Davidson, B. (BD)

Transect no	Tide correction	Time in	Time out	Diver #1	Diver #2	Width	Transect side	Start depth	Ending depth	MLLW start	MLLW End	Length Interval	No. geoducks	No. horseclams	Bottom type #1	Bottom type #2	Percent veg cover	Veg type #1	Veg type #2	Comments
1	9	12:02	12:32	PD	SW	2	a	36	51	27	42	50	49		snd	sil	75	lbk		first geoduck seen at 36 fsw
1	9	12:02	12:32	PD	SW	2	a	51	64	42	55	50	6		snd	sil	50	lbk		
1	9	12:02	12:32	PD	SW	2	a	64	70	55	61		3		snd	sil	0			
2	3	16:21	16:59	PD	SW	2	a	18	28	-3	25	50	14		snd		40	lbk		first geoduck at 18 fsw
2	3	16:21	16:59	PD	SW	2	a	28	38	25	35	50	23		snd		85	lbk		hard to see due to LBK
2	3	16:21	16:59	PD	SW	2	a	38	54	35	51	50	7		snd		90	lbk		too much LBK to see
2	3	16:21	16:59	PD	SW	2	a	54	58	51	55	10	0		snd		60	lbk		
2	3	16:21	16:59	PD	SW	2	a	58	60	55	57		2		snd		10	lbk		
3	5	8:38	9:08	PD	MP	2	a	15	18	10	13		0							
3	5	8:38	9:08	PD	MP	2	a	18	60	13	55		14		snd	sil	100	lbk		
3	5	8:38	9:08	PD	MP	2	a	60	70	55	65		0		snd	sil	75	lbk		deeper = same substrate w/fewer vege (<5%)
4	8	11:10	11:42	SW	KH	2	a	0	34	-8	26		1	10	snd	shl	40	lbk		
4	8	11:10	11:42	SW	KH	2	a	34	53	26	45	50	65		snd	shl	20	lbk		
4	8	11:10	11:42	SW	KH	2	a	53	63	45	55	15	22		snd		20	lbk		
4	8	11:10	11:42	SW	KH	2	a	63	70	55	62	18	11		snd		20	lbk		
5	7	9:24	10:05	PD	MP	2	a	20	30	13	23		19		snd		40	lbk		
5	7	9:24	10:05	PD	MP	2	a	30	40	23	33		2		snd		100	lbk		
5	7	9:24	10:05	PD	MP	2	a	40	62	33	55		##		snd		30	lbk		100 m bedrock, good geoduck last part
6	9	10:22	10:57	PD	MP	2	a	36	64	27	55		##		snd	sil	25	lbk		
6	9	10:22	10:57	PD	MP	2	a	64	70	55	61		0		snd					
7	10	11:22	11:43	PD	MP	2	a	35	40	25	30		0		rck					
7	10	11:22	11:43	PD	MP	2	a	40	65	30	55		##		snd		10	lbk		
7	10	11:22	11:43	PD	MP	2	a	65	70	55	60		##		snd		10	lbk		
8	3	16:38	17:08	BD	MP	2	a	30	32	27	29		0		snd		0			started at edge of macro bed, sea otters on site
8	3	16:38	17:08	BD	MP	2	a	32	38	29	35	50	23		snd		0			
8	3	16:38	17:08	BD	MP	2	a	38	58	35	55	6	3							
8	3	16:38	17:08	BD	MP	2	a	58	63	55	60		0		bld		10	lbk		
8	3	16:38	17:08	BD	MP	2	a	63	70	60	67		3		snd		0			sand waves start
9	9	10:28	10:52	PD	KH	2	a	40	60	31	51		0		rck		10	lbk		terrible shows
9	9	10:28	10:52	PD	KH	2	a	60	70	51	61		0		rck		0			rck stops at 70'

-continued-

Transect no.	Tide correction	Time in	Time out	Diver #1	Diver #2	Width	Transect side	Start depth	Ending depth	MLLW start	MLLW End	Length Interval	No. geoducks	No. horseclams	Bottom type #1	Bottom type #2	Percent veg cover	Veg type #1	Veg type #2	Comments
9	9	10:28	10:52	PD	KH	2	a	70	75	61	66		13		snd		0			habitat looks good
9	9	10:28	10:52	PD	KH	2	b	61	70	52	61		21		snd		0			rck begins at 61 fsw
10	8	10:00	10:12	PD	SW	2	a	0	37	-8	29		0	0	rck		50	mac	lbk	
10	8	10:00	10:12	PD	SW	2	a	37	52	29	44		0	0	cbl	snd	10	lbk		
10	8	10:00	10:12	PD	SW	2	a	52	63	44	55	33	88				0			none showing
10	8	10:00	10:12	PD	SW	2	a	63	70	55	62	10	6				0			
10	8	10:00	10:12	PD	SW	2	b	43	46	35	38	18	82		snd		0			
10	8	10:00	10:12	PD	SW	2	b	46	64	38	56	55	217		snd		0			
10	8	10:00	10:12	PD	SW	2	b	64	70	56	62	10	117		snd		0			
11	3	15:40	16:00	SW	KH	2	a	34	50	31	47		0	0	rck		20	lbk		
11	3	15:40	16:00	SW	KH	2	a	50	58	47	55		0	0	cbl	snd	10	lbk		
11	3	15:40	16:00	SW	KH	2	a	58	70	55	67		0	0	cbl		0			
12	5	14:54	15:27	PD	KH	2	a	30	60	25	55	36	##		snd		75	lbk		shows are poor - mostly depressions
12	5	14:54	15:27	PD	KH	2	a	60	70	55	65	8	21		snd		0			visibility 40'
13	8	9:12	9:53	MP	BD	2	a	0	24	-8	16		0		rck	bld	75	lbk		
13	8	9:12	9:53	MP	BD	2	a	24	27	16	19		0		snd		25	lbk		
13	8	9:12	9:53	MP	BD	2	a	27	34	19	26	50	75		snd		0			
13	8	9:12	9:53	MP	BD	2	a	34	36	26	28		0		sil	rck	0			
13	8	9:12	9:53	MP	BD	2	a	36	39	28	31	35	47		snd		0			
13	8	9:12	9:53	MP	BD	2	a	39	40	31	32		0							
13	8	9:12	9:53	MP	BD	2	a	40	48	32	40	50	##		snd		0			
13	8	9:12	9:53	MP	BD	2	a	48	53	40	45	27	63		snd		0			
13	8	9:12	9:53	MP	BD	2	a	53	52	45	44		0		snd	gvl	0			BD lost weight, @60', 1-hr safety interval, didn't repeat transect, @52' rck w/no geoduck habitat
14	3	15:42	16:20	MP	BD	2	a	18	22	15	19		0	0	snd		0			rock shallower, mounded sand
14	3	15:42	16:20	MP	BD	2	a	22	34	19	31		0		rck		100	mac	lbk	depth range was 22-6-34 ->swam over reef
14	3	15:42	16:20	MP	BD	2	a	34	35	31	32	10	46		snd		0			large (37 cm) lemon peel nudibranch
14	3	15:42	16:20	MP	BD	2	a	35	39	32	36		0		rck					rock reef
14	3	15:42	16:20	MP	BD	2	a	39	58	36	55	41	57		snd		0			more otter excavations at 42 fsw
14	3	15:42	16:20	MP	BD	2	a	58	70	55	67	14	13		snd	sil	0			
15	2	14:00	14:35	MP	BD	2	a	11	30	9	28		0	0	rck		40	mac	lam	
15	2	14:00	14:35	MP	BD	2	a	30	41	28	39		0		snd		0			
15	2	14:00	14:35	MP	BD	2	a	41	44	39	42	50	11		snd		20	lbk		
15	2	14:00	14:35	MP	BD	2	a	44	46	42	44	50	2		rck	snd	10	lbk		
15	2	14:00	14:35	MP	BD	2	a	46	61	44	59	27	1		snd		10	lbk		
15	2	14:00	14:35	MP	BD	2	a	61	70	59	68		4		snd		0			
16	9	10:48	11:12	MP	BD	2	a	0	23	-9	14		0		cbl		100	mac	lam	
16	9	10:48	11:12	MP	BD	2	a	23	34	14	25		0		rck		50	mac		
16	9	10:48	11:12	MP	BD	2	a	34	38	25	29	11	22		snd		0			

-continued-

Transect no.	Tide correction	Time in	Time out	Diver #1	Diver #2	Width	Transect side	Start depth	Ending depth	MLLW start	MLLW End	Length Interval	No. geoducks	No. horseclams	Bottom type #1	Bottom type #2	Percent veg cover	Veg type #1	Veg type #2	Comments
16	9	10:48	11:12	MP	BD	2	a	38	53	29	44		0		rck					
16	9	10:48	11:12	MP	BD	2	a	53	64	44	55	14	4		snd		0			
16	9	10:48	11:12	MP	BD	2	a	64	70	55	61	4	1		snd		0			
17	8	12:44	13:04	MP	BD	2	a	0	18	-8	10		0		snd		40	mac		
17	8	12:44	13:04	MP	BD	2	a	18	60	10	52		0		rck	snd	40	mac		
17	8	12:44	13:04	MP	BD	2	a	60	63	52	55		0		snd		0			
17	8	12:44	13:04	MP	BD	2	a	63	70	55	62		4		snd		0			many excavations at 70 fsw
18	7	13:19	13:42	MP	BD	2	a	20	36	13	29		0		snd		0			sand mounds or 'waves'
18	7	13:19	13:42	MP	BD	2	a	36	38	29	31		0		snd		0			sand flat
18	7	13:19	13:42	MP	BD	2	a	38	55	31	48		0		rck		90	lbk		
18	7	13:19	13:42	MP	BD	2	a	55	62	48	55		1		snd	cbl	0			old excavations 60-65 fsw
18	7	13:19	13:42	MP	BD	2	a	62	70	55	63		0		snd		0			this transect was a sand strip between two rock 'reefs'

Appendix D. Transect Summary

Port Alice Transect Summary

Cruise Dates: September 16 - 17, 1998.
Each transect represents 275.28 meters of shoreline.

Transect Number	Transect Width	Side A Number of Geoducks	Side B Number of Geoducks	Geoducks per Meter of Shore	Geoducks per Represented Shoreline
1	2	58		29.0	7,983
2	2	46		23.0	6,331
3	2	14		7.0	1,927
4	2	99		49.5	13,626
5	2	170		85.0	23,399
6	2	287		143.5	39,502
7	2	606		303.0	83,409
8	2	29		14.5	3,992
9	2	13	21	8.5	2,340
10	2	94	416	127.5	35,098
11	2	0		0.0	0
12	2	154		77.0	21,196
13	2	453		226.5	62,350
14	2	116		58.0	15,966
15	2	18		9.0	2,478
16	2	27		13.5	3,716
17	2	4		2.0	551
18	2	1		0.5	138
				Total =	324,002

Appendix E. Weight Summary.

Weight (grams) of geoduck clams sampled at six sites in the Port Alice area, 1998.

Sample Site	Transect #10	Transect #13	Transect #4
	765	832	1,249
	764	908	1,468
	572	893	1,634
	1,283	932	1,604
	647	1,241	709
	778	1,133	592
	818	904	1,028
	929	976	
	730	622	
	605	847	
	780	1,069	
	1,091		
	785		
	939		
Number of Samples	14	11	7
Average	820	942	1,183
Maximum	1,283	1,241	1,634
Minimum	572	622	592
Standard Deviation	190.21	164.86	421.15

Combined Weight Statistics

Number of Samples	32
Average	941
Maximum	1,634
Minimum	572
Standard Deviation	279.47

Weight Sample Locations and Comments

Site	Divers	Latitude	Longitude	Ease of Digging
Transect #4	KH/BD	55°50.232	133°33.368	difficult
Transect #13	KH/BD	55°49.553	133°35.830	difficult
Transect #10	KH/SW	55°49.927	133°35.485	difficult

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